Total Maximum Daily Load

Evaluation

for

2 Segments of the New River

in the

Suwannee River Basin

(Fecal Coliform)

Submitted to:

The U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:
The Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

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Table of Contents

List of Tables

List of Figures

Appendices

EXECUTIVE SUMMARY

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into three categories, supporting, partially supporting, or not supporting their designated uses depending on water quality assessment results. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years.

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and in-stream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

The State of Georgia has identified the New River reach from Westside Branch to Gum Creek in the Suwannee River basin as not supporting the water quality standard criteria for fecal coliform bacteria. The New River reach from Reedy Creek to Gum Branch is identified as partially supporting the water quality standard criteria for fecal coliform bacteria. These reaches have a water use classification of fishing and a fecal coliform bacteria water quality standard as described below:

> For the months of May through October, fecal coliform not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. For the months of November through April, fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample.

Fecal coliform bacteria data were collected from the New River near Tifton, Georgia (GAEPD site 09018301) in 1998 to calculate four distinct geometric mean values. Two of the geometric means exceeded the criteria. As a result, five miles of the New River from Westside Branch to Gum Creek was added to the State's 303(d) list and scheduled for a TMDL evaluation. One geometric mean exceeded the criteria for the New River near Lenox, Georgia (GAEPD site 09019001). As a result, seven miles of the New River from Reedy Creek to Gum Branch was added to the State's 303(d) list and scheduled for a TMDL evaluation.

The analysis performed to develop the TMDL for fecal coliform bacteria for the New River used dynamic hydrologic and water quality modeling techniques that considered the characteristics of the watershed, meteorology, hydrology, and land use. The model used local meteorological data and local watershed and stream characteristics in the simulation. Land use in the watershed was characterized from Landsat Thematic Mapper digital images developed in 1995. Land use activities contributing fecal coliform bacteria simulated using the model included septic tanks, cattle grazing, poultry operations, manure management, urban development, and wildlife. Model parameterization for urban, agricultural, and forest land uses were provided by the USEPA. National Pollutant Discharge Elimination System (NPDES) permitted discharges were also included in the modeling analysis.

A simulation period of 10 years (1989 – 1998) was used to develop the fecal coliform bacteria TMDL. Load reductions were applied until the simulated 30-day geometric mean of the fecal coliform bacteria counts did not exceed the water quality geometric mean standard. Modeling assumptions were considered conservative to constitute an implied margin of safety.

Model results indicate that nonpoint sources related to urban stormwater runoff have a significant impact on the fecal coliform bacteria loadings in the upper watershed (Westside Branch to Gum Creek). Agricultural practices have an additional impact on the fecal coliform bacteria loadings in the lower watershed (Reedy Creek to Gum Branch). Reductions in these loading rates in the New River watershed reduce the in-stream fecal coliform bacteria levels.

A possible allocation scenario that would meet in-stream water quality standards in both segments of the New River is an 81 percent reduction in fecal loads in the upper watershed, and a 58 percent reduction in the lower watershed. Management practices that could be used to implement this TMDL include controlling leaking septic and sewer collection lines and urban runoff, adoption of NRCS resource management practices including covering manure and poultry litter stacks exposed to the environment; reducing animal access to streams; and applying manure to croplands at agronomical rates. Best management practices (BMPs) should be developed to address urban and agricultural runoff during extreme storm events.

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into three categories, supporting, partially supporting, or not supporting their designated uses depending on water quality assessment results. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years.

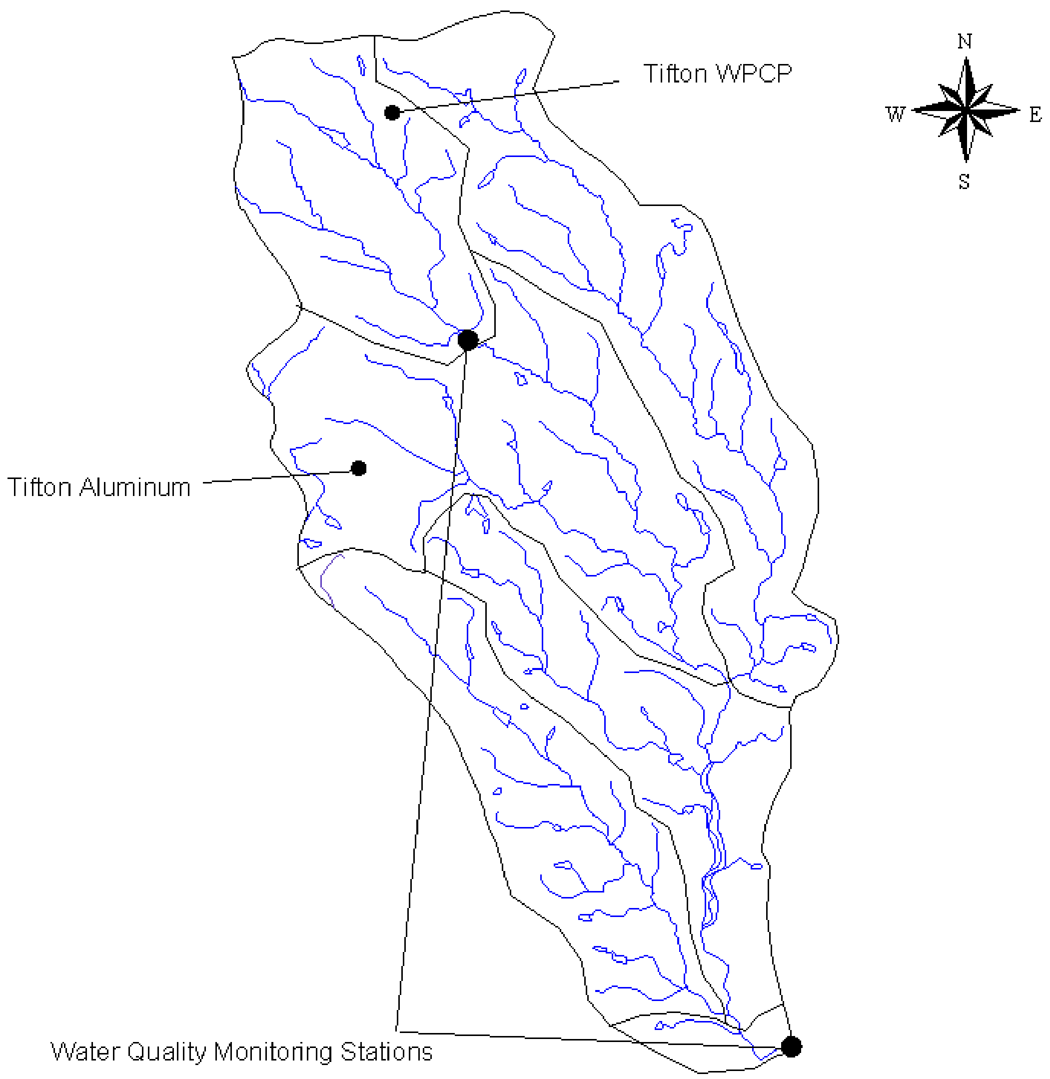
Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

Fecal coliform bacteria data were collected from the New River near Tifton, Georgia (GAEPD site 09018301) in 1998 to calculate four distinct geometric mean values. Two of the geometric means exceeded the criteria. As a result, five miles of the New River from Westside Branch to Gum Creek was added to the State's 303(d) list and scheduled for a TMDL evaluation. One geometric mean exceeded the criteria for the New River near Lenox, Georgia (GAEPD site 09019001). As a result, seven miles of the New River from Reedy Creek to Gum Branch was added to the State's 303(d) list and scheduled for a TMDL evaluation.

1.2 Watershed Description

The New River watershed is located in the Suwannee River basin in southern Georgia, in Tift, Berrien, and Cook Counties (See Figure 1). The New River is a tributary to the Withlacoochee River. The upper watershed evaluated in this report has a drainage area of about 10 square miles (GAEPD site 09018301). The lower watershed (GAEPD site 09019001) has a drainage area of about 70 square miles.

The land use characteristics of the New River watershed were determined using data from Georgia's Multiple Resolution Land Coverage (MRLC). This coverage is based on Landsat Thematic Mapper digital images developed in 1995. The classification is based on a modified Anderson level one and two system. Table 1 lists the land use distribution in the watershed. The data show that the watershed is predominately forested (64 percent) with the next predominate land use being agriculture (pasture/hay and row crops) (30 percent). Landuse coverage for the watershed is shown in Figure 2.



Total Maximum Daily Load (Fecal Coliform)
New River Watershed
June 2000

Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

Figure 1
New River Watershed

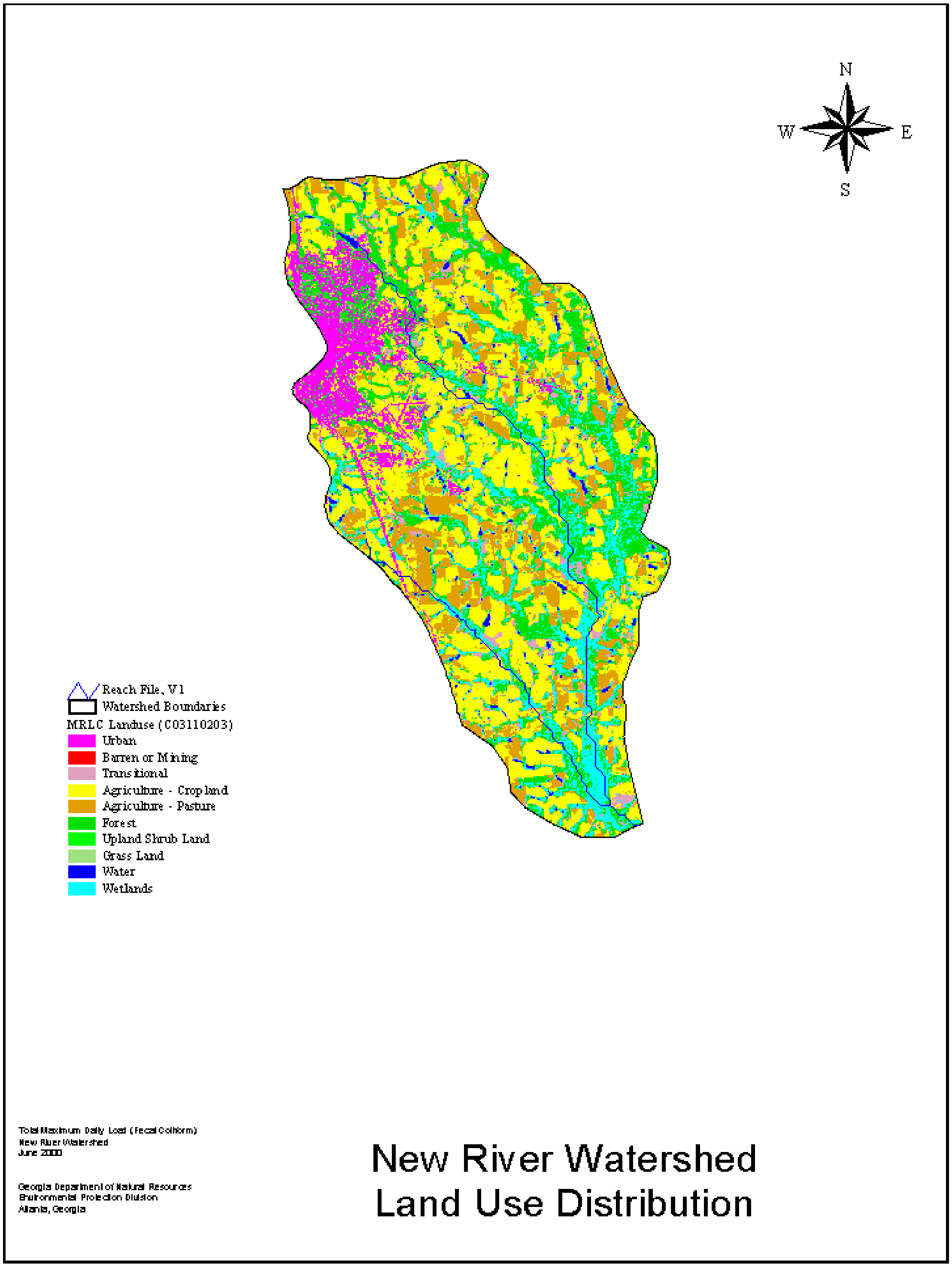

N
W
E
S
Reach File, V1
Watershed Boundaries
MRLC Landuse (C03110203)
Urban
Barren or Mining
Transitional
Agriculture - Cropland
Agriculture - Pasture
Forest
Upland Shrub Land
Grass Land
Water
Wetlands
Total Maximum Daily Load (Fecal Coliform)
New River Watershed
June 2000
Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia
New River Watershed
Land Use Distribution

Table 1. Landuse Distribution by Subwatershed

Landuse	Upper New River near Tifton, GA		New River near Lenox, GA	
	Area (ac)	Percent	Area(ac)	Percent
Bare Rock/Sand/Clay	18	0.3	74	0.2
Deciduous Forest	183	2.8	1779	3.9
Emergent Herbaceous Wetlands	6	0.1	369	0.8
Evergreen Forest	1275	19.5	6459	14.2
High Intensity Commercial/Industrial/ Transportation	445	6.8	1349	3.0
High Intensity Residential	392	6.0	729	1.6
Low Intensity Residential	898	13.8	1462	3.2
Mixed Forest	229	3.5	1203	2.7
Open Water	70	1.1	606	1.3
Other Grasses (Urban/recreational; e.g. parks, lawns)	129	2.0	519	1.1
Pasture/Hay	550	8.4	7131	15.7
Quarries/Strip Mines/Gravel Pits				
Row Crops	1822	27.9	16530	36.4
Transitional	384	5.9	2450	5.4
Woody Wetlands	129	2.0	4722	10.4
Total	6528	100	45382	100

1.3 Water Quality Standard

The water use classification for the New River is fishing. The fishing classification water quality standard for fecal coliform bacteria as stated in Georgia's Rules and Regulations for Water Quality Control Chapter 391-3-6-.03(6)(c) is:

(c) Fishing: Propagation of Fish, Shellfish, Game and Other Aquatic Life; secondary contact recreation in and on the water; or for any other use requiring water of a lower quality:

(iii) Bacteria: For the months of May through October, when water contact recreation activities are expected to occur, fecal coliform not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. Should water quality and sanitary studies show fecal coliform levels from non-human sources exceed 200/100 ml (geometric mean) occasionally, then the allowable geometric mean fecal coliform shall not exceed 300 per 100 ml in lakes and reservoirs and 500 per 100 ml in free flowing freshwater streams. The months of November through April, fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample. The State does not encourage swimming in surface waters since a number of factors, which are beyond the control of any State regulatory agency, contribute to elevated levels of fecal coliform. For waters designated as approved shellfish harvesting waters by the appropriate State agencies, the requirements will be consistent with those established by the State and Federal agencies responsible for the National Shellfish Sanitation Program. The requirements are found in the National Shellfish Sanitation Program Manual of Operation, Revised 1988, Interstate Shellfish Sanitation Conference, U.S. department of Health and Human Services (PHS/FDA), and the Center for Food Safety and Applied Nutrition. Streams designated as generally supporting shellfish are listed in Paragraph 391-3-6-.03(14).

2.0 WATER QUALITY ASSESSMENT

Water quality monitoring data were collected at the New River near Tifton, Georgia and at the New River near Lenox, Georgia during 1998. Table 2 lists the fecal coliform bacteria data results at these stations as well as computed geometric mean values. The data collected were four instantaneous samples obtained within a 30 day period. These data results were compared with the fecal coliform bacteria water quality standard to assess compliance.

Table 2. Water Quality Monitoring Data

Date	New River near Tifton Fecal Coliform Bacteria (MPN/100 ml)	Geometric Mean	Date	New River near Lenox Fecal Coliform Bacteria (MPN/100 ml)	Geometric Mean
02/25/98	80		01/21/98	90	
03/04/98	50		02/04/98	1100	
03/18/98	80		02/11/98	50	
03/24/98	50	63	02/18/98	1300	283
04/08/98	13000		06/04/98	80	
04/15/98	230		06/10/98	110	
04/22/98	1400		06/17/98	170	
05/06/98	1100	1465	06/30/98	20	74
07/08/98	<20		07/30/98	330	
07/15/98	20		08/12/98	700	
07/22/98	<20		08/20/98	490	
08/05/98	<20	<20	08/27/98	330	440
10/01/98	22000		11/02/98	80	
10/08/98	490		11/09/98	490	
10/22/98	2200		11/23/98	330	
10/29/98	50	1043	11/30/98	<20	127

The data show that geometric mean criteria were exceeded in April and October for the upper segment, and in August for the lower segment. The upstream segment (New River near Tifton) was listed for not supporting the designated use and the downstream reach of the New River (near Lenox) was listed for partially supporting the designated use.

3.0 SOURCE ASSESSMENT

A source assessment is used to characterize the known and suspected sources of fecal coliform bacteria in the watershed for use in the water quality model, and the development of the TMDL. The general sources of fecal coliform bacteria are point and non-point sources. National Pollutant Discharge Elimination System (NPDES) permittees discharging treated domestic waste are the primary point sources of fecal coliform bacteria.

Nonpoint sources of fecal coliform bacteria are diffuse sources that cannot be identified as entering the water body at a single location. These sources generally involve land activities that contribute fecal coliform bacteria to streams during a rainfall runoff event. Nonpoint sources of fecal coliform bacteria considered in the analysis include:

- Wildlife,
- Land application of agricultural manure,
- Grazing animals,
- Leaking septic systems,
- Urban development, and
- Leaking sewer collection lines.

For nonpoint sources involving agricultural activities, the Natural Resources Conservation Service (NRCS) was consulted for information and parameters to be used to characterized agricultural activities represented in the water quality model

3.1 Point Source Assessment

There are two permitted NPDES discharges identified in the New River watershed upstream from the listed segments. These two facilities are the Tifton Water Pollution Control Plant (NPDES GA0048470) and the Tifton Aluminum Company (NPDES GA0000124), see Figure 1. The Tifton Water Pollution Control Plant has a permitted flow rate of 8 million gallons per day (MGD), and discharges to the New River. This discharge was modeled with a fecal coliform load at permit limits of 200 counts/100 ml. (In accordance with GAEPD standards, all NPDES dischargers in the watershed shall meet end-of-pipe water quality standards of 200 counts/100ml.) The Tifton Aluminum Company discharges treated industrial wastewater to Gum Creek. This discharge has no fecal coliform associated with it, and no fecal load was modeled for this facility.

3.2 Nonpoint Source Assessment

3.2.1 Wildlife

Wildlife deposit fecal coliform bacteria with their feces onto the land where it can be transported during a rainfall runoff event to nearby streams. In the water quality model, the wildlife fecal coliform contribution is accounted for in the deer population. The deer population is estimated to be 30 to 45 animals per square mile in this area (personal comm., NRCS and Georgia WRD State Deer Biologist, Nov. 1999). The upper limit of 45 deer per square mile has been chosen to account for deer and all other wildlife present in the watershed. It is assumed that the wildlife population remains constant throughout the year, and that wildlife is uniformly distributed on all land classified in the MRLC database as forest, pasture, cropland, and wetlands.

3.2.2 Land Application of Agricultural Manure

Processed agricultural manure from confined hog, dairy cattle, and poultry operations is generally collected in lagoons and applied to land surfaces during the months April through October. Hog manure is applied only to cropland. NRCS estimates that 75 percent of cattle manure and poultry litter is applied to cropland and 25 percent is applied to pasture land. Manure application rates are included in Appendix A.

Data sources for confined feeding operations include the Census of Agriculture and the NRCS. Table 3 shows animal distribution in the watershed. The livestock data are based on the 1997 Census of Agriculture and is reported by county. The county data are distributed to the watersheds based on the percentage of agricultural area in each subwatershed classified as pasture/hay. Cattle numbers reported in the census data also represent other breeds of cattle and calves besides dairy and beef.

Table 3. Livestock Distribution

Livestock	New River near Tifton (individuals)	New River near Lenox (individuals)
Beef Cow	88	1657
Milk Cow	87	693
Cattle	175	2350
Chickens	0	0
Chickens Sold	0	0
Hogs	119	1703
Sheep	2	24

Hog farms in the watershed operate by confining the animals or allowing them to graze in small pastures or pens. It is assumed that all of the hog manure produced by either farming method is applied evenly to available cropland. Application rates of hog manure to cropland vary monthly according to management practices.

As shown in Table 3, cattle operations in the watershed are about 70 percent beef cattle and 30 percent dairy cattle. In dairy farms, the cows are confined for a limited period each day, during which time they are fed and milked. This is estimated to be four hours per day for each dairy cow. The percentage of manure collected during confinement is applied to the available pasture and cropland in the watershed. Application rates of dairy cow manure to pasture and cropland vary monthly according to management practices.

3.2.3 Grazing Animals

Cattle, including beef and dairy, and hogs, spend time grazing on pasture land and depositing feces onto the land. During a rainfall runoff event, a portion of this material containing fecal coliform bacteria is transported to streams. Beef cattle spend all their time in pasture, while dairy cattle and hogs are confined periodically. The percentage of feces deposited during grazing time is used to estimate the fecal coliform loading rates from pasture land.

In addition, cattle and other unconfined animals often have direct access to streams that pass through pastures. Feces deposited in streams by grazing animals are included in the water quality model as a point source having constant flow and concentration. To calculate the amount of bacteria introduced into streams by cattle, it is assumed that only the beef cow population have access to the streams and of those approximately 12 percent will defecate in the stream (personal communication, NRCS and USEPA).

3.2.4 Leaking Septic Systems

Table 4 shows estimates from county census data of the number of septic systems in the watershed. In south Georgia, NRCS estimates that there are approximately 2.37 people per household on septic systems. For modeling purposes, it is assumed that 20 percent of the septic systems in the watershed leak. Leaking septic systems are included in the water quality model as a point source having constant flow and concentration.

Table 4. Septic Systems

Watershed	Septic Systems
New River near Tifton	261
New River near Lenox	1934

3.2.5 Urban Development

Fecal coliform bacteria from urban areas may originate from various sources including runoff through storm water sewers (e.g., residential, commercial, industrial, and road transportation), illicit discharges of sanitary waste, and runoff from improper disposal of waste materials. Overflowing sanitary sewers and leaking collection lines are not considered a significant source of fecal coliform bacteria in the New River watershed.

4.0 MODELING APPROACH

Establishing the relationship between the in-stream water quality and the source loadings is an important component of TMDL development. It provides for both the identification of sources, and their relative contribution, as well as the examination of potential water quality changes resulting from varying management options to meet the water quality standard. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling techniques. In this section, the numerical modeling techniques developed to simulate fecal coliform bacteria fate and transport in the watershed are discussed.

4.1 Model Selection

A dynamic computer model was selected for the fecal coliform bacteria TMDL evaluation in order to satisfy a variety of objectives. The first objective is to simulate the time varying behavior of fecal coliform bacteria deposition on the land surface and transport to receiving water bodies. The second objective was to use a continuous simulation period to identify the critical condition and from which to develop the TMDL. Finally, the continuous simulation model provides the means to incorporate seasonal effects on the production and fate of fecal coliform bacteria. A series of computer-based tools were used to accomplish these objectives.

First, the Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display and analyze GIS information including land use, land type, point source discharges, soil types, population, and stream characteristics. The WCS was used to identify and summarize the sources of fecal coliform bacteria in the watershed, as well the other factors that affect its fate and transport.

Information collected using WCS was used in a series of spreadsheet applications designed to compute fecal coliform bacteria loading rates in the watershed from varying land uses including urban, agricultural, and forestry as described in Section 3.0. Computed loading rates were used in a hydrologic and water quality model, NPSM (Non-Point Source Model), to simulate the deposition and transport of fecal coliform bacteria, and the resulting water quality response. The NPSM program uses the Hydrologic Simulation Program Fortran (HSPF) to develop the TMDL. NPSM simulates nonpoint source runoff as well as the transport and flow of pollutants in stream reaches. A necessary feature of NPSM is its ability to integrate both point and nonpoint sources of fecal coliform bacteria and determine the in-stream water quality response.

4.2 Model Set Up

The New River watershed above Lenox was delineated into six watersheds in order to characterize the relative fecal coliform bacteria contributions from the significant contributing subwatersheds (see Figure 1). Watershed delineation was based on the RF3 stream coverage and elevation data. In addition, this discretization allows for management and load reduction alternatives to be varied by subwatershed.

A continuous simulation period from January 1, 1988 to December 31, 1998, was used in the analysis. The period from January 1, 1988 to December 31, 1988, was used to allow the model results to stabilize. The period from January 1, 1989 to December 31, 1998, was used to identify the critical condition period from which to develop the TMDL. Since field data were collected during the period January 1, 1998 to December 31, 1998, this period was used for model calibration.

An important factor driving model results is the precipitation data contained in the meteorological data file used in the simulation. The pattern and intensity of rainfall affects the build-up and wash-off of fecal coliform bacteria from the land into the streams, as well as the dilution potential of the stream. Data from the Doles, Georgia meteorological station were used in the simulation.

4.3 Fecal Coliform Bacteria Source Representation

Both point and nonpoint sources of fecal coliform bacteria are represented in the water quality model. Because of varying decay or die-off rates for fecal coliform bacteria, and varying transport assumptions, the fecal coliform bacteria loadings from these sources are computed separately. The following sections describe the assumptions used for the various sources described in Section 3.0. Appendix A contains the worksheets used to compute the loading rates used in the model.

4.3.1 NPDES Discharge

There are two permitted NPDES discharges identified in the New River watershed upstream from the listed segments. These two facilities are the Tifton Water Pollution Control Plant (NPDES GA0048470) and the Tifton Aluminum Company (NPDES GA0000124). The Tifton Water Pollution Control Plant has a permitted flow rate of 8 million gallons per day (MGD), and discharges to the New River. This was represented in the water quality model by a constant flow and fecal coliform bacteria concentration. This discharge was modeled with a flow rate equal to the facility's permitted flow rate of 8 MGD, and a fecal coliform bacteria concentration equal to the water quality standard of 200 counts per 100 milliliters, or 2.528×10^9 counts per hour. The Tifton Aluminum Company discharges treated industrial wastewater to Gum Creek. This discharge has no fecal coliform associated with it, and no fecal load was modeled for this facility

4.3.2 Wildlife

Fecal coliform contributions from wildlife are represented in the model based on deer population. In the model, deer are uniformly distributed to forest, pasture, cropland and wetland areas at a density of 45 deer per square mile. The assumed loading rate is 5.0×10^8 counts per animal per day based on best professional judgement.

4.3.3 Land Application of Agricultural Manure

Fecal coliform accumulation and build-up rates resulting from the land application of hog and cattle manure and poultry litter are represented using monthly input values. For modeling purposes it is assumed that a typical poultry farmer produces 5.5 batches of chickens per year. Therefore, the number of chickens on a farm at any one time is about one-fifth the number shown in Table 3. The animal fecal loading rates are: 1.24×10^{10} counts/day/hog (NCSU, 1994); 1.06×10^{11} counts/day/cow (NCSU, 1994); and 1.38×10^8 counts/day/chicken (NCSU, 1994).

4.3.4 Grazing Animals

Beef and dairy cows in the watershed contribute manure containing fecal coliform bacteria directly to pastures during grazing. Because there is no monthly variation in animal access to pastures in south Georgia, the fecal loading rates to pasture land does not vary significantly throughout the year. Contributions of fecal coliform from wildlife are included in the pasture loading rate.

4.3.5 Urban Development

Urban land use represented in the MRLC database includes areas classified as: high intensity commercial, industrial, transportation, low intensity residential, high intensity residential, and transitional. A single, area-weighted loading rate from urban areas is used in the model and is based on the percentage of each urban land use type in the watershed and build-up and accumulation rates referenced in Horner (1992). This rate is assumed constant throughout the year.

4.4 Model Calibration

The calibration of the watershed model involves both hydrology and water quality components. The hydrology calibration is performed first and involves comparing simulated streamflows to historic streamflow data from a U.S. Geological Survey (USGS) stream gaging station for the same period of time. Calibration of the hydrologic model involves adjusting model parameters (e.g., evapotranspiration, infiltration, upper and lower zone storage, groundwater storage and recession, and interflow discharge) used to represent the hydrologic cycle, until an acceptable agreement is achieved between simulated and observed streamflows. There is no streamflow gage in the New River watershed. The USGS gage on the Withlacoochee River near Bemiss, Ga. (USGS 023177483) was used to calibrate the flow model. Results of the hydrology calibration are included in Appendix B.

The only fecal coliform bacteria data available for the New River were those data collected during 1998. These data were used to calibrate the water quality model. Model calibration results are shown in Appendix B. Results show that the model adequately simulates peaks in fecal coliform bacteria in response to rainfall events. Often a high observed value is not simulated in the model due to lack of rainfall at the meteorological station as compared to the rainfall occurring in the watershed, or an unknown source that is not included in the model. A comparison of simulated water quality concentrations and observed concentrations for sampling stations in the watershed are included in Appendix B.

4.5 Critical Conditions

Critical conditions for non-point fecal coliform sources are an extended dry period followed by a rainfall runoff event. During the dry weather period, fecal coliform bacteria build up on the ground and when it rains, it is washed off the ground by rainfall runoff. Critical conditions for point sources occur during low streamflows and corresponding reduced dilution potential. Both conditions are simulated in the NPSM model.

The ten-year simulation period from January 1, 1989, to December 31, 1998, was used to identify the critical conditions from which to base the fecal coliform bacteria TMDL. This 10-year period contained a range of hydrological conditions including low and high streamflows. The range of hydrological conditions provided an opportunity to identify the fecal coliform bacterial critical conditions period, as well as the amount of in-stream fecal coliform bacteria in the stream that can be used to develop the TMDL.

5.0 MODEL RESULTS

5.1 Existing Conditions

Model results indicate that nonpoint sources related to urban stormwater runoff have a significant impact on the fecal coliform bacteria loadings in the upper watershed (Westside Branch to Gum Creek). Agricultural practices have an additional impact on the fecal coliform bacteria loadings in the lower watershed (Reedy Creek to Gum Branch). Reductions in these loading rates in the New River watershed reduce the in-stream fecal coliform bacteria levels.

Nonpoint source loading rates representing existing model conditions are shown in Table 5.

5.2 Critical Condition

Results of the ten-year simulation for existing conditions are shown in Figures 3 and 4. From this figure critical conditions can be determined. The 30-day critical period in the model is the time period preceding the largest simulated violation of the geometric mean standard (USEPA TMDL Guidance Document). Achieving water quality standards during this time period ensures that water quality standards can be achieved for the ten-year period. For the listed segments in the New River watershed, the highest violation of the 30-day geometric mean occurred on August 13, 1995. The critical period is July 15, 1995 through August 13, 1995.

Evaluation of the sources contributing fecal coliform bacteria indicate that if the watershed loads are reduced by 81 percent the fecal coliform bacteria water quality standard can be achieved. A large portion of the load reduction may occur if urban storm water management and NRCS resource management practices are followed.

Figure 3. Simulated Geometric Mean of Existing and Allocated Fecal Coliform Bacteria Levels: New River near Tifton.

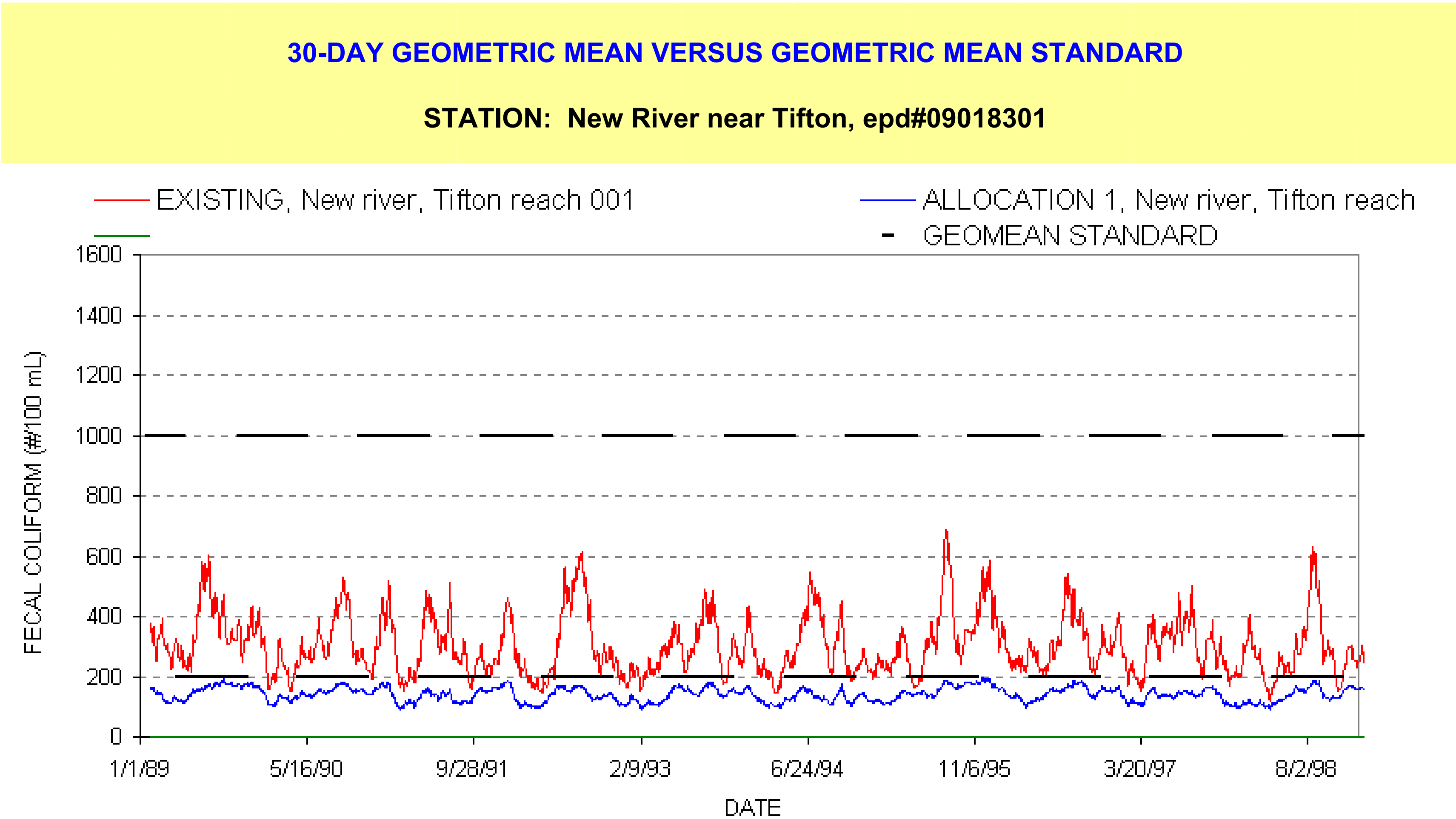
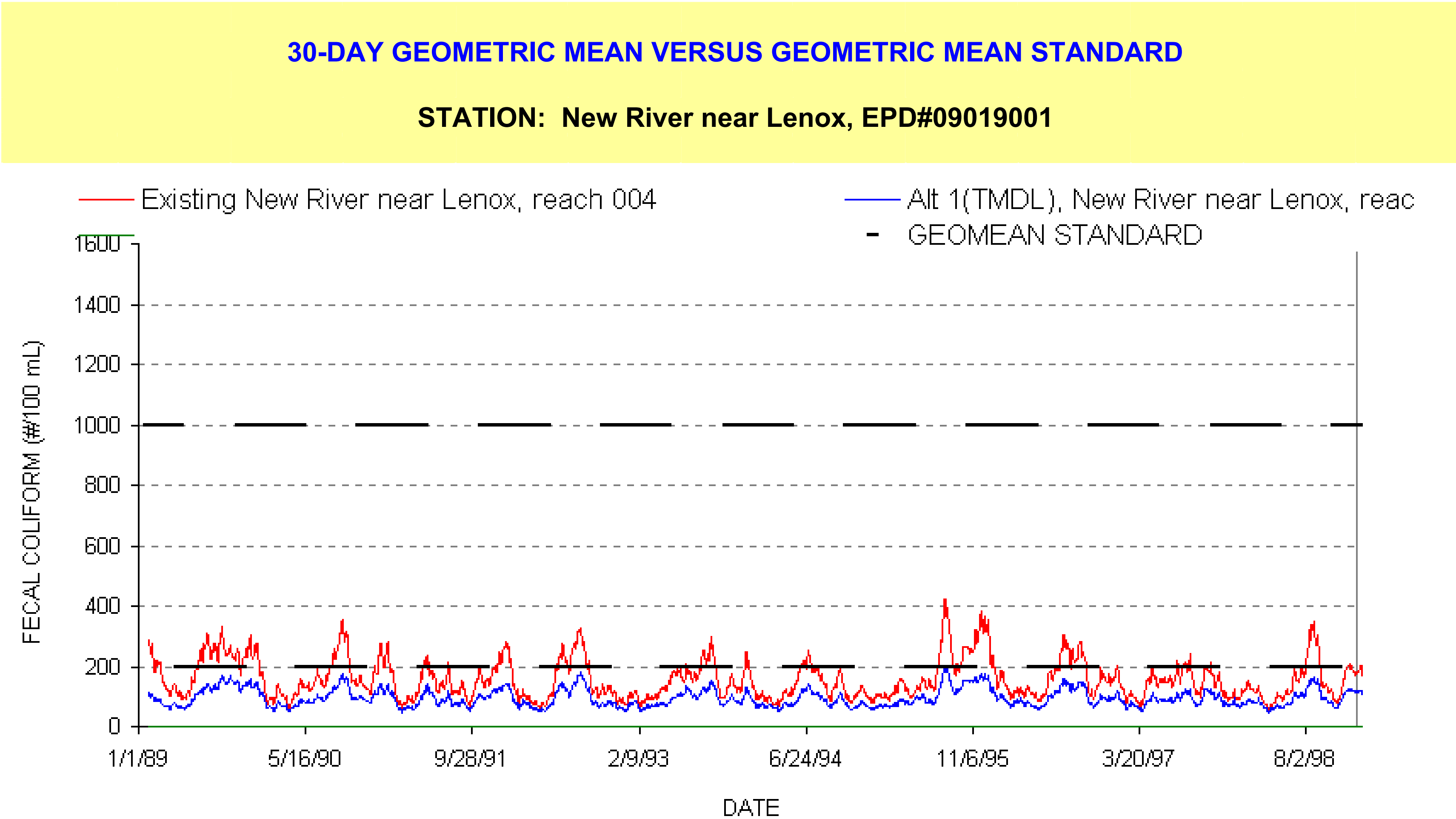


Figure 4. Simulated Geometric Mean of Existing and Allocated Fecal Coliform Bacteria Levels: New River near Lenox.



6.0 ALLOCATION

6.1 Total Maximum Daily Load

A TMDL is the sum of the individual waste load allocations (WLA) for point sources and load allocations (LA) for nonpoint sources and natural background (40 CFR 130.2). The sum of these components may not result in an exceedence of water quality standards for that water body. To protect against exceedences, the TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body. Conceptually, a TMDL can be expressed as follows:

$$\text{TMDL} = \Sigma\text{WLAs} + \Sigma\text{LAs} + \text{MOS}$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while maintaining water quality standards. TMDLs establish allowable pollutant loadings that are less than or equal to the TMDL, and thereby provide the basis to establish water quality based controls. For some pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For fecal coliform bacteria the TMDL are expressed as counts per 30 days. Therefore, the TMDL represents the maximum fecal coliform bacteria load that can be assimilated by the stream during the critical 30-day period while maintaining the fecal coliform bacteria water quality standard of 200 counts/100 ml.

The total maximum daily load of fecal coliform bacteria was determined by adding the WLA and the LA. The MOS (as described in Section 6.5) was implicitly included in the TMDL analysis and does not factor directly in the TMDL equation as shown above. Table 6 shows the computation of the total maximum daily load using the WLAs and the LAs for the critical condition. The TMDLs are summarized in Appendix C. The TMDL for fecal coliform bacteria in the upper segment of the New River is 3.82×10^{12} counts per 30 days. The TMDL for fecal coliform bacteria in the lower segment of the New River is 1.49×10^{13} counts per 30 days.

6.2 Waste Load Allocations

There are two permitted NPDES discharges identified in the New River watershed upstream from the listed segments. These two facilities are the Tifton Water Pollution Control Plant (NPDES GA0048470) and the Tifton Aluminum Company (NPDES GA0000124). The Tifton Water Pollution Control Plant has a permitted flow rate of 8 million gallons per day (MGD), and discharges to the New River. This was represented in the water quality model by a constant flow and fecal coliform bacteria concentration. This discharge was modeled with a flow rate equal to the facility's permitted flow rate of 8 MGD, and a fecal coliform bacteria concentration equal to the water quality standard of 200 counts/100 ml. Therefore, the WLA for this facility is 1.82×10^{12} counts per 30 days. The Tifton Aluminum Company discharges treated industrial wastewater to Gum Creek. This discharge has no fecal coliform associated with it, and no fecal load was modeled for this facility. Future facility permits will require end-of-pipe criteria equivalent to the water quality standard of 200 counts/100 ml.

6.3 Load Allocations

The nonpoint fecal coliform bacteria sources in the model have two transportation modes. First, animals in the stream and leaking septic systems are modeled as direct sources to the stream. The other nonpoint sources result from fecal coliform bacteria that are applied to land. Fecal coliform applied to land is subject to a die-off rate and an absorption rate before it is transported to the stream.

Model results indicate that nonpoint sources related to urban stormwater runoff have a significant impact on the fecal coliform bacteria loadings in the upper watershed (Westside Branch to Gum Creek). Agricultural practices have an additional impact on the fecal coliform bacteria loadings in the lower watershed (Reedy Creek to Gum Branch). Reductions in these loading rates in the New River watershed reduce the in-stream fecal coliform bacteria levels.

A possible allocation scenario that would meet in-stream water quality standards in both segments of the New River is an 81 percent reduction in fecal loads in the upper watershed, and a 58 percent reduction in the lower watershed. Management practices that could be used to implement this TMDL include controlling leaking septic and sewer collection lines and urban runoff, adoption of NRCS resource management practices including covering manure and poultry litter stacks exposed to the environment; reducing animal access to streams; and applying manure to croplands at agronomical rates. Best management practices (BMPs) should be developed to address urban and agricultural runoff during extreme storm events. Fecal coliform loading rates for this allocation scenario are shown in Table 5. Fecal coliform loading from wildlife is represented in the model as background conditions. Additional monitoring and characterization of the watershed could be conducted to verify the various unknown sources of fecal coliform bacteria in the watershed.

Table 5. Load Allocations in the New River Watershed

Watershed ID	Existing Load (Counts / 30 days)	Allocated Load (Counts / 30 days)	Percent Reduction
New River near Tifton	2.03×10^{13}	3.82×10^{12}	81
New River near Lenox	3.53×10^{13}	1.49×10^{13}	58

Table 6. TMDL Components (counts/30 days)

Watershed ID	WLA	LA	MOS	TMDL
New River near Tifton	1.817×10^{12}	2.006×10^{12}	implicit	3.823×10^{12}
New River near Lenox	1.817×10^{12}	1.313×10^{13}	implicit	1.495×10^{13}

6.4 Seasonal Variation

Seasonal variability was incorporated in the continuous simulation water quality model by using varying monthly loading rates and daily meteorological data. The combination of a continuous simulation with varying loading rates and meteorological conditions creates a condition of seasonal variation.

6.5 Margin of Safety

The MOS is a required component of TMDL development. There are two basic methods for incorporating the MOS: 1) Implicitly incorporate the MOS using conservative model assumptions to develop allocations; or 2) Explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For this TMDL the MOS was implicitly incorporated into the modeling process by selecting a critical time period and critical default values for each of the summer and winter seasons based on the results of a 10-year simulation.

7.0 RECOMMENDATIONS

7.1 Monitoring

GAEPD has adopted the basin approach to water quality management; an approach that divides Georgia's major river basins in to five groups. During each annual cycle, GAEPD's water quality monitoring resources are concentrated in one of the basin groups. One goal is to continue to monitor 303d listed waters. Those watersheds identified as having both urban and agricultural activities, microbial source tracking may be used in the future to clarify the specific sources of fecal coliform bacteria. During the next monitoring cycle in the south Georgia river basins, water quality monitoring will help further characterize water quality conditions resulting from the implementation of management practices in the watershed. Additional characterization may be needed in the watershed to clarify the unknown sources of fecal coliform bacteria.

7.2. Point and Nonpoint Source Approaches

Permitted discharges will be regulated through the NPDES permitting process described in this report. Georgia is working with local governments, agricultural, and forestry agencies such as the Natural Resources Conservation Service, the Georgia Soil and Water Conservation Commission, and the Georgia Forestry Commission to foster the implementation of best management practices to address nonpoint sources. In addition, public education efforts will be targeted to individual stakeholders to provide information regarding the use of best management practices to protect water quality.

7.3 Public Participation

A thirty day public notice will be provided for this TMDL. During this time the availability of the TMDL will be public noticed, a copy of the TMDL will be provided as requested, and the public will be invited to provide comments on the TMDL.

REFERENCES

American Society of Agricultural Engineers (ASAE), 1998. ASAE Standards, 45th Edition, Standards Engineering Practices Data.

GAEPD, *Rules and Regulations For Water Quality Control, Chapter 391-3-6,* November 23, 1998, Georgia Department of Natural Resources, Environmental Protection Division.

Horner, 1992. Water Quality Criteria/Pollutant Loading Estimation/Treatment Effectiveness Estimation. In R.W. Beck and Associates, Covington Master Drainage Plan, King County Surface Water Management Division, Seattle, Washington.

Horsley & Whitten, Inc., 1996. Identification and Evaluation of Nutrient Bacterial Loadings to Maquiot Bay, Brunswick and Freeport, Maine. Casco Bay Estuary Project.

Metcalf & Eddy, 1991. *Wastewater Engineering: Treatment, disposal, Reuse,* Third Edition, McGraw-Hill, Inc., New York.

North Carolina Cooperative Extension Service, North Carolina State University (NCSU) College of Agriculture and Life Sciences, Raleigh, Livestock Manure Production and Characterization in North Carolina, January 1994.

USEPA. 1991a. *Guidance for Water Quality –based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

USEPA, 1998. Better Assessment Science Integrating Point and Nonpoint Sources (BASINS), Version 2.0 User's Manual, U.S. Environmental Protection Agency, Office of Water, ` Washington D.C.

APPENDIX A

Water Quality Model Assumptions

The data from the following references are accessed in the remaining worksheets.

Animal Fecal Coliform Production Rates

Values from ASAE (1998) are used as default values when available.

	From ASAE, 1998	*From NCSU, 1994*	*From Metcalf & Eddy, 1991*	*From LIRPB, 1978*	*Best Professional Judgement*	*Mean*
Animal	**FC (#/animal/day)**	**FC (#/animal/day)**	**FC (#/animal/day)**	**FC (#/animal/day)**	**FC (#/animal/day)**	**FC (#/animal/day)**
Cow	--	--	5.40E+09	3.75E+09	--	4.57E+09
Dairy cow	1.01E+11	1.04E+11	--	--	--	1.03E+11
Beef cow	1.04E+11	1.06E+11	--	--	--	1.05E+11
Hog	1.08E+10	1.24E+10	8.90E+09	8.91E+09	--	1.02E+10
Sheep	1.20E+10	1.22E+10	1.80E+10	--	--	1.41E+10
Horse	4.20E+08	4.18E+08	--	--	--	4.19E+08
Chicken	--	--	2.40E+08	2.37E+08	--	2.38E+08
Chicken (Layer)	1.36E+08	1.38E+08	--	--	--	1.37E+08
Turkey	9.30E+07	8.93E+07	1.30E+08	--	--	1.04E+08
Duck	2.43E+09	2.43E+09	1.10E+10	1.10E+10	--	6.71E+09
Goose	--	--	--	4.90E+10	--	4.90E+10
Deer	--	--	--	--	5.00E+08	5.00E+08
Beaver	--	--	--	--	2.50E+08	2.50E+08
Raccoon	--	--	--	--	1.25E+08	1.25E+08
Dog	--	--	--	4.09E+09	--	4.09E+09
Other Ag Animal	--	--	--	--	0.00E+00	0.00E+00
Other Wildlife	--	--	--	--	0.00E+00	0.00E+00

From ASAE, 1998	**Total Manure prod**	**Typical Animal Mass**	**Manure prod per animal**	**Fecal Coliform**	**Fecal Coliform**	**Manure prod**
Animal	**(lb/day per 1,000 lb animal)**	**(lb)**	**(lb/day)**	**(#/day E10 per 1,000 lb anim**	**(#/day)**	**(lb/yr)**
Dairy cow	86	1400	120	7.2	1.01E+11	43946
Beef cow	58	800	46	13	1.04E+11	16936
Hog	84	135	11	8	1.08E+10	4139
Sheep	40	60	2	20	1.20E+10	876
Horse	51	1000	51	0.042	4.20E+08	18615
Chicken (Layer)	64	4	0	3.4	1.36E+08	93
Turkey	47	15	1	0.62	9.30E+07	257
Duck	110	3	0	81	2.43E+09	120

From LIRPB, 1978	**Waste produced**	**FC content**	**FC produced**
Animal	**(g waste/animal/day)**	**(#/g waste)**	**(#/animal/day)**
Dog	227	1.80E+07	4.09E+09
Duck	336	3.27E+07	1.10E+10
Cattle	16,300	2.30E+05	3.75E+09
Chicken	182	1.30E+06	2.37E+08
Swine	2,700	3.30E+06	8.91E+09

Built-Up Fecal Coliform Accumulation Rates

	From: Horner, 1992	
Land Use	**median #/ha/yr**	**median #/acre/day**
Road	1.80E+08	2.00E+05
Commercial	5.60E+09	6.21E+06
Single family low density	9.30E+09	1.03E+07
Single family high density	1.50E+10	1.66E+07
Multifamily residential	2.10E+10	2.33E+07

From: Scott McDonald Georgia WRD State Deer Biologist November 1999

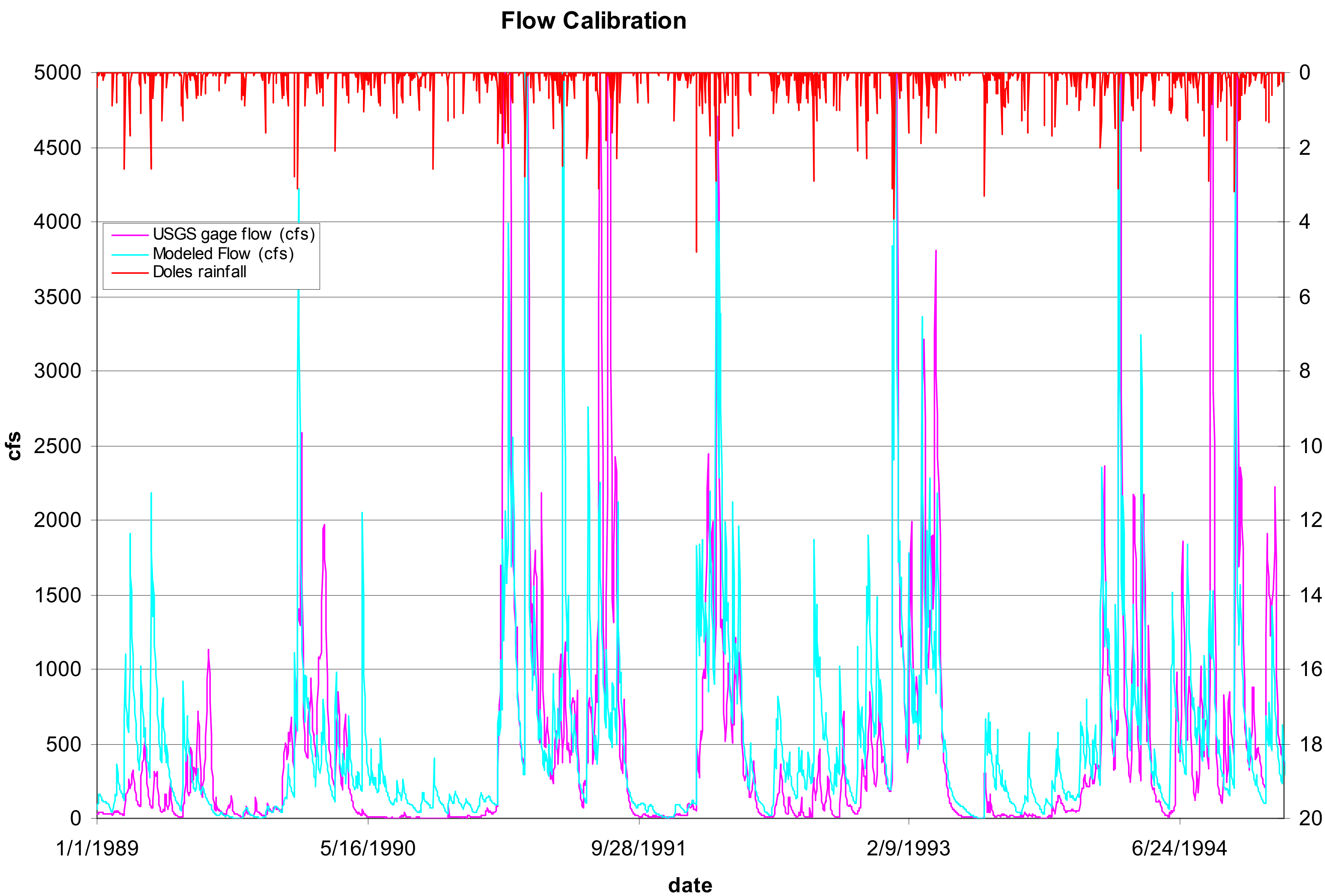
Georgia deer population is 35-45 head per square mile.

The following assumptions are made for septic contributions.

Assume a failure rate for septics in the watershed:	20
Assume the average FC concentration reaching the stream (from septic overcharge) is:	1.00E+04
Assume a typical septic overcharge flow rate of:	70

APPENDIX B

Hydrodynamic and Water Quality Model Calibration



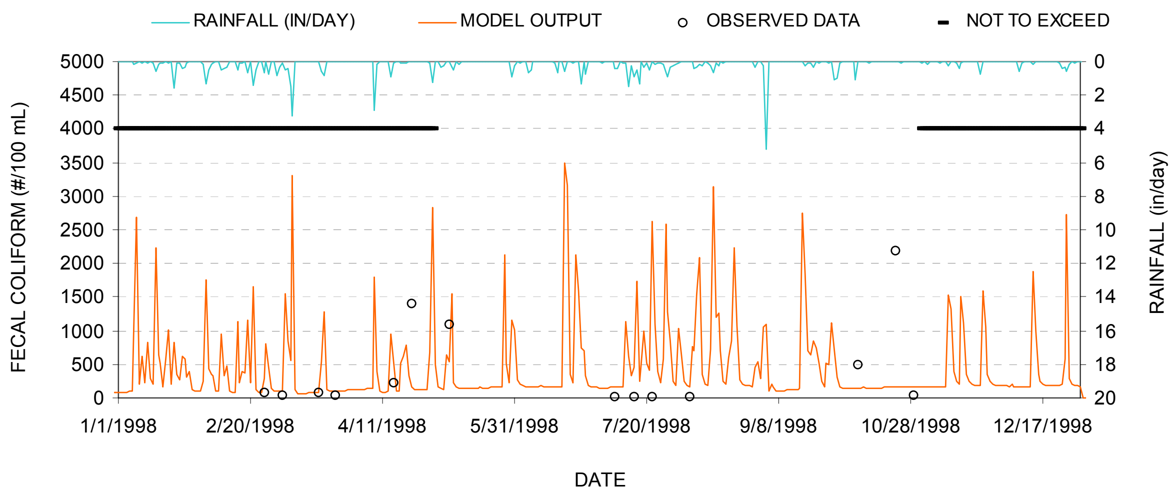
Flow Calibration
USGS gage flow (cfs)
Modeled Flow (cfs)
Doles rainfall
cfs
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
20
18
16
14
12
10
8
6
4
2
date
1/1/1989
5/16/1990
9/28/1991
2/9/1993
6/24/1994

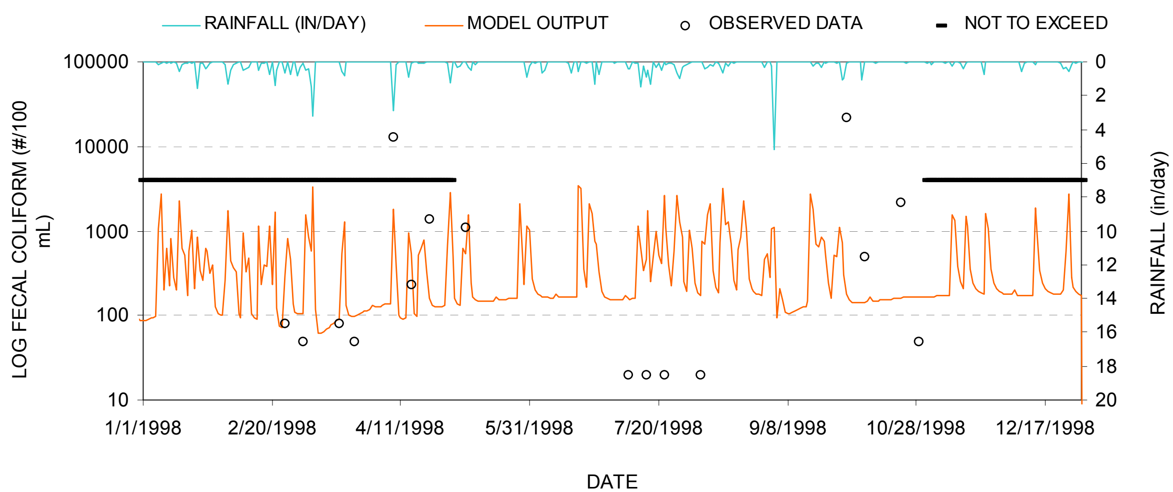
Water Quality Model Calibration to Existing Conditions
MULTI-YEAR TIMESERIES MODEL VS DATA

STATION: **New River near Tifton, epd#09018301**

MODEL RUN: **1**

1 = EXISTING
2 = ALLOCATION 1
3 = ALLOCATION 2



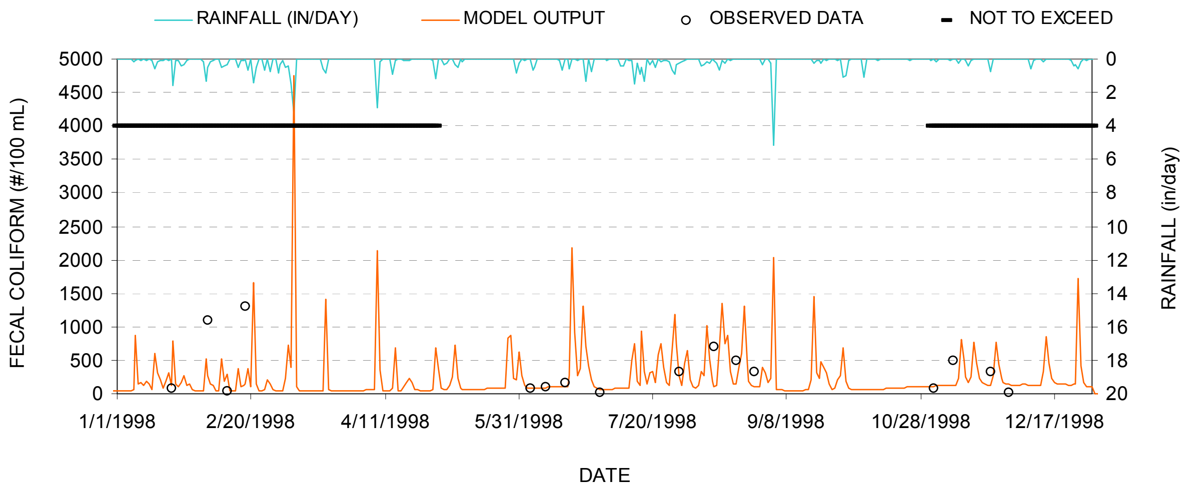


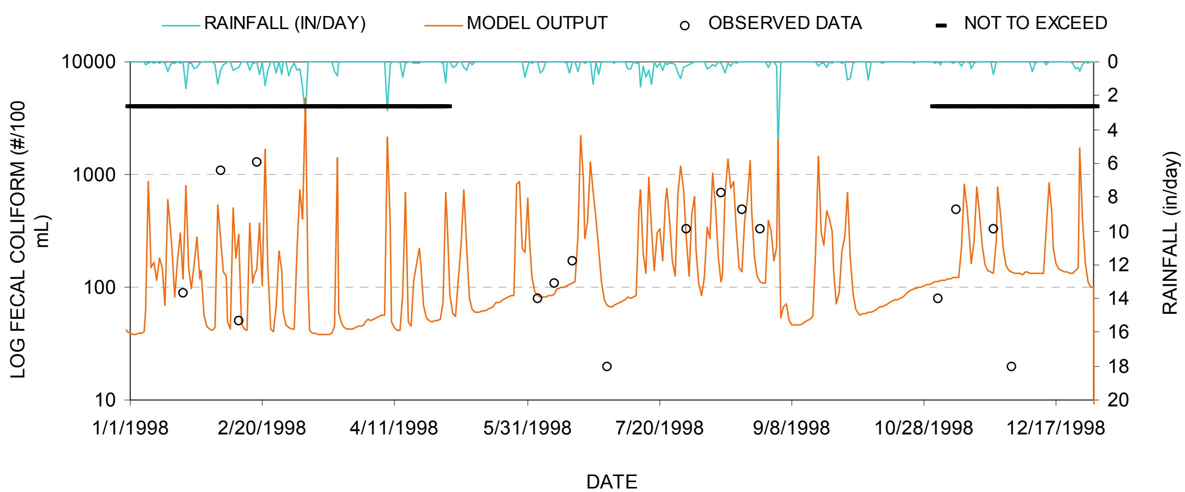
Water Quality Model Calibration to Existing Conditions
MULTI-YEAR TIMESERIES MODEL VS DATA

STATION: **New River near Lenox, EPD#09019001**

MODEL RUN: 1

1 = EXISTING Existing New River near Lenox, reach 004
2 = ALLOCATION 1 Alt 1(TMDL), New River near Lenox, reach 0
3 = ALLOCATION 2 1/0/1900





APPENDIX C

Total Maximum Daily Load Summary Memorandum

SUMMARY MEMORANDUM
Total Maximum Daily Load (TMDL)
2 Segments of the New River in the Suwannee River Basin

1. 303(d) Listed Waterbody Information

State:	**Georgia**
County:	**Tift; Cook**
Major River Basin:	**Suwannee**
8-Digit Hydrologic Unit Code(s):	**03110203**
Waterbody Name:	**New River**
Location:	**Westside Branch to Gum Creek near Tifton, GA; Reedy Creek to Gum Branch near Lenox, GA**
Stream Length:	**5 miles; 7miles**
Watershed Area:	**10 square miles; 70 square miles**
Tributary to:	**Withlacoochee River**
Constituent(s) of Concern:	**Fecal Coliform Bacteria**
Designated Use:	**Fishing (not supporting; partially supporting designated use)**

Applicable Water Quality Standard:

May through October fecal coliform not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. For the months of November through April, fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample.

2. TMDL Development

Analysis/Modeling:

The Non-Point Source Model (NPSM)/Hydrologic Simulation Program Fortran (HSPF) was used to develop this TMDL. A daily time step was used to simulate hydrologic and water quality conditions. The model was developed for the entire watershed upstream from the 303(d) listed segment.

Critical Conditions:

A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period represents a range of hydrologic and meteorologic conditions.

Seasonal Variation:

A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period represents a range of hydrologic and meteorologic conditions including seasonal variations.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA): (Reach 1.) **1.817×10^{12}**
(Reach 2.) **1.817×10^{12} counts/30 days**

Note: All future permitted discharges shall meet the water quality standard for fecal coliform bacteria of 200/100 ml as a geometric mean.

Load Allocation (LA): (Reach 1.) **2.006×10^{12}**
(Reach 2.) **1.313×10^{13} counts/30 days**

Margin of Safety (MOS): Implicit (conservative modeling assumptions)

Total Maximum Daily Load (TMDL): (Reach 1.) **3.823×10^{12}**
(Reach 2.) **1.495×10^{13} counts/30 days**